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Microelectromechanical X-band Integrated Tile for Planar Array Program Final Report

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Agreement: DAAD01-99-C-0024

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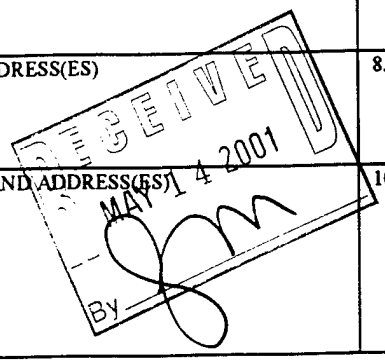

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12 b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Phase shift devices with low insertion losses (<2 dB) are required for novel, high performance RF apertures. Examples of these architectures include RF lenses, and quasi-active. Wideband, two dimensional planar array subassemblies with embedded true time delay is an enabling technology for an affordable space based radar reconnaissance, surveillance, and target acquisition (RSTA) system that provides unprecedented world wide, continuous, all weather, high resolution synthetic aperture radar (SAR) maps and ground moving target indications (GMTI). Successful development and application of this technology can reduce the number of transmit/receive modules required for large, wide band, two dimensional space based radar active, electronically scanned aperture (AESA) antennas by an order of magnitude over conventional, current technology. While industry continues to concentrate on developing affordable transmit/receive modules, this technology dramatically reduces the number of modules required, with associated reductions in power and weight. Although true time delay techniques have been developed using current technology, these approaches are too heavy and costly to support the affordability requirements for a constellation of satellites. This final report describes the risk reduction effort performed to develop a concept utilizing micro-electromechanical systems (MEMS) to implement embedded true time delay in planar array subassemblies.

14. SUBJECT TERMS
MEMS
RF
Phase shifters

15. NUMBER OF PAGES
6

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39155.EL

NORTHROP GRUMMAN

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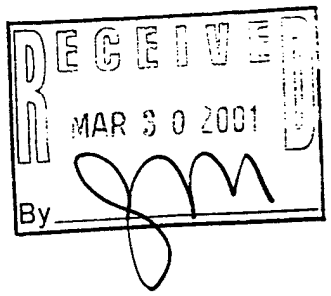
Northrop Grumman Corporation
Post Office Box 17319
Baltimore, Maryland 21203

EMD-MISC-013
January 30, 2001



USARO AMSRL-RO-EL
U.S. Army Research Office
4300 S. Miami Boulevard
Research Triangle Park, NC 27709-2211

Attention: Dr. James Harvey

Subject: Submission of Monthly Technical and Financial Status Report for 11/99 - 11/00 - CLIN 0002AD

Reference: Contract No. DAAD19-99-C-0024 (Ref. NG No. 30000235)

Enclosure: Microelectromechanical X-Band Integrated Tile for Planar Array Monthly and Financial Status Report - 1 copy

Enclosed you will find one (1) copy of the subject status report as required per Section F of the reference contract. This report has been prepared in accordance with Attachment B of the contract and includes status on activities from 11/99 through 11/00.

Should you have any questions concerning the above, please direct them to Dr. Carl Freidhoff at 410-993-2911.

Sincerely,
Northrop Grumman Corporation

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39155-EL

Microelectromechanical X-Band Integrated Tile for Planar Array
Northrop Grumman Monthly Technical and Financial Status Report

Contract number:	P-39155-EL
Program:	Microelectromechanical X-Band Integrated Tile for Planar Array
Start of Work:	8 February 1999
Reporting Period:	1 November 1999 to 31 November 2000
Report Date:	19 November 1999
CDRLs:	Monthly Technical Status Reports No. 10 through 22

Program Objectives:

The objective of this effort is to design, fabricate and measure performance of two and four bit time delay units (TDU) to be used in the X-Band region. The S parameter data will be determined for a set number of both types of TDU and provided to the Government as specified in the contract. Tested four bit TDU's will be delivered to the Northrop Grumman ESSS Discoverer II office and the two bit TDU's will be delivered to DARPA/STO.

Task Descriptions:

The program tasks include Task AAA - Preliminary design of the TDU, Task AAB - MEMS/Metal Reliabiilty Modeling, Task AAC - Fabrication of TDU, Task AAD - Reliabiility Testing of TDU, Task AAE - Environmental Testing TDU, Task AAF - Comparison of Model and Empirical Data and Task AAG - Program management.

Description of Work:

During the period, a number of fabrication lots of devices were produced of the single element, two-bit time delay units (TDUs). The processing used for these devices was based upon the experience gained from the development of RF MEMS done under Northrop Grumman internal research and development funds. The reliability testing of the previously produced quad element, four-bit time delay units provided feedback that allowed processing improvements to be made and applied to the single element, two-bit time delay units.

Experimental or Special Purpose Equipment

None designed or developed during this reporting period.

Personnel Status

All critical personnel are available at this time.

Meeting Results

Quarterly review with Dr. John Smith in March 2000 to discuss the progress of RF MEMS development at Northrop Grumman and provide an expected delivery schedule for the single element, two-bit time delay units.

Problems Identified this Month/Proposed Solutions

Program completed during this period.

Problems Identified Previous Month/Resolution

Program completed during this period.

Subcontractor Status

Not applicable within this program

Significant Accomplishments this Period

1. Final design of single element, two-bit time delay unit completed.
2. Fabrication of two-bit time delay unit completed.
3. Wafer testing of two-bit time delay unit completed with enough devices for 64 deliverables identified as shown in Figure 3.
4. Packaging of single element, two-bit time delay units completed with significant yield with units under 1.5 dB insertion loss as shown in Figures 4 and 5.
5. Packaged time delay units and data delivered to DARPA SPO in November 2000.
6. Final report delivered.

Planned Efforts For The Next Month/Action Items

Program completed this period. No action items remaining.

Program Management Plan: Performance and Cost Reports

A summary of the program schedule status is shown in Figure 1. The program spend plan along with actual expenditure and funding is illustrated in figure 2. The figures following figure 2 show results from fabrication lots funded by internal Northrop Grumman funds, Discoverer II funds and funds from this contract. All process development of the fabrication process were developed using Northrop Grumman internal funds. All of the data is provided since the story of the progress made can not be adequately shown with the lots funded by this program alone.

Contract Funding Status

	Plan	Actual
Given months: November 1999 to November 2000	$116,991	$102,554
FY99 Year to Date	$789,659	$804,096
FY00 Year to Date	$116,991	$102,554
Contract Start to Date	$906,650	$906,650

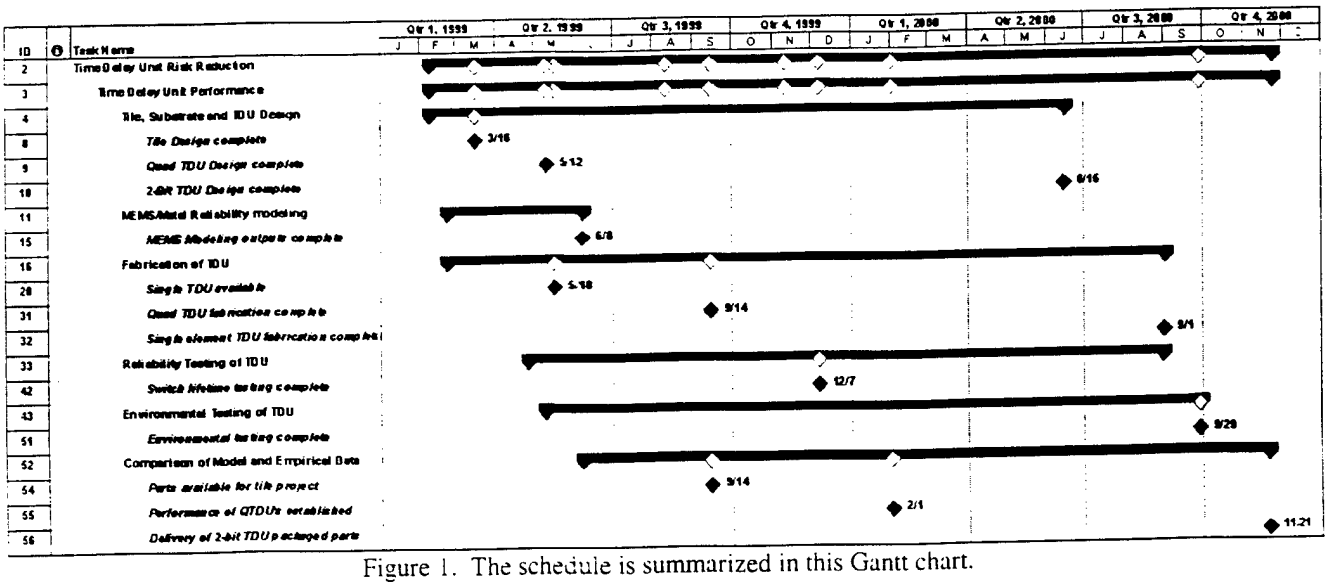

Figure 1. The schedule is summarized in this Gantt chart.

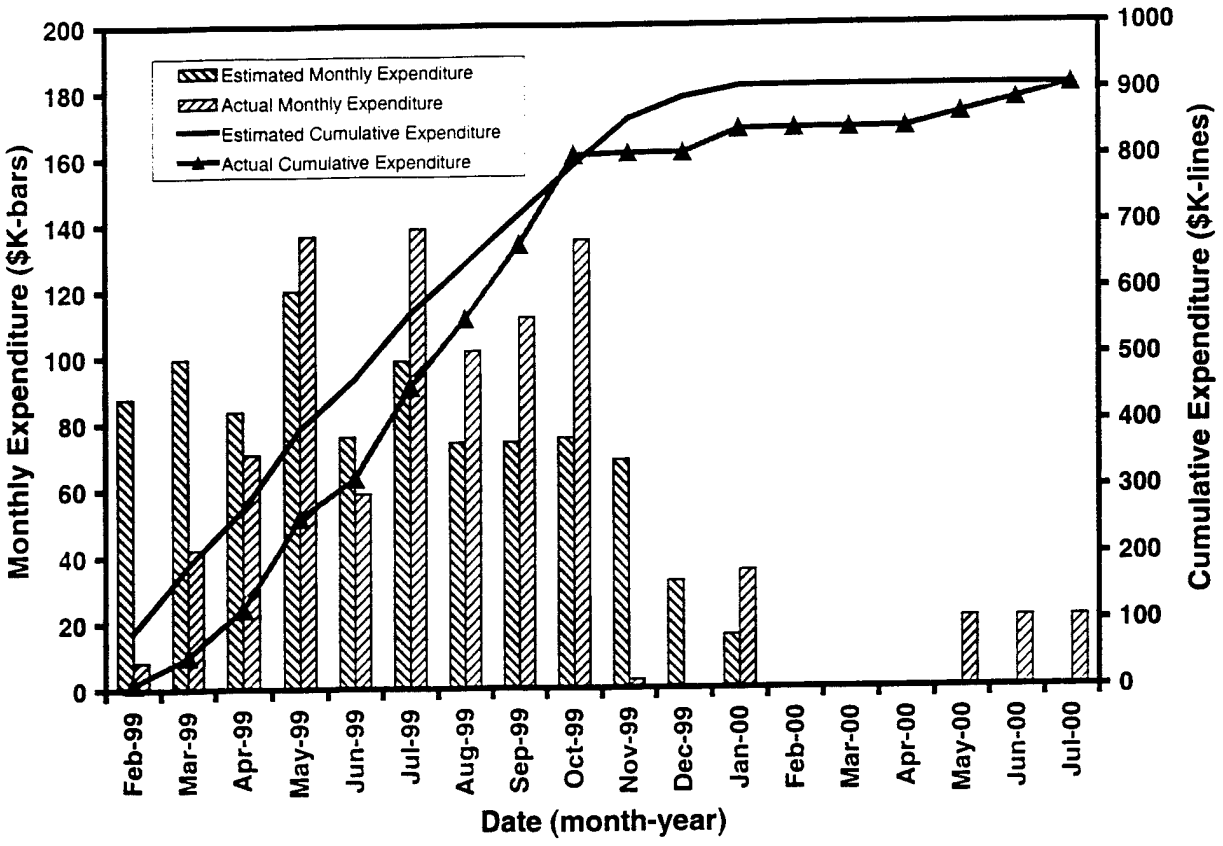

Figure 2. The cumulative program spend plan, funding and actual spending are shown.

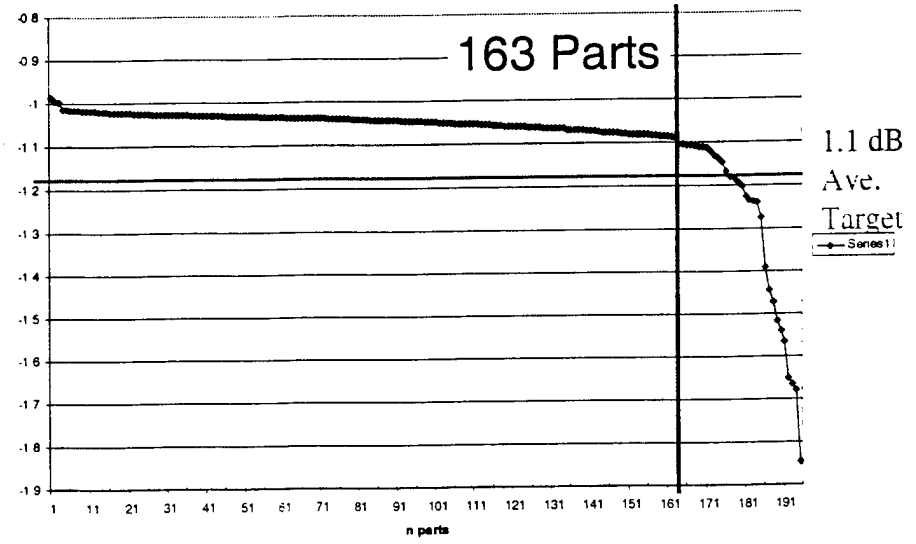

Figure 3. A sufficient number of parts were obtained to provide the sixty-four packaged parts goal for the program deliverable. As can be seen, the insertion loss target was exceeded for these parts.

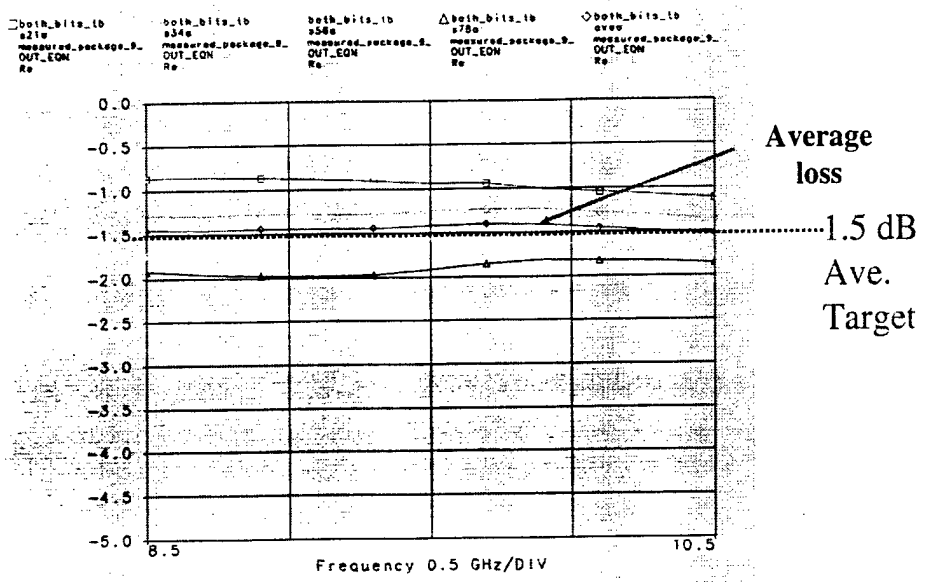

Figure 4. A commercially available, non-heremtic package from StratEdge Corporation was used to package these devices. The packaged devices achieved or exceeded the 1.5 dB insertion loss goal.

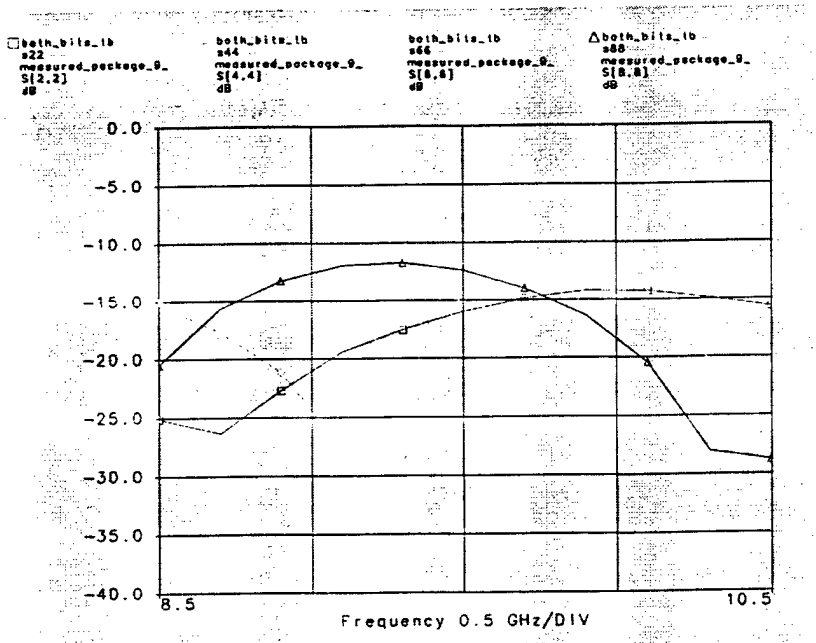

Figure 5. The packaged insertion loss was driven by the package parameters and can be improved with a modified package, but still provides sufficient performance for the two bit time delay unit.